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DESIGN AND ANALYSIS OF HELICAL GEAR USING SOLIDWORKS AND ANSYS SOFTWARES

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ABSTRACT

Gears are one of the important parts and that are indispensable for mechanical power transmission systems. There are many stresses that can cause failure in gears in mechanical transmission systems. Bending Stress is one of the most common problems in the gears. Stress analysis is of great importance, because it can predict failure and the optimal design can be achieved. This paper is designed to analyze bending stress using the ANSYS program. The model is drawn by the SOLIDWORKS program, and the analysis is done by using three models of the gears. The face width is changed to compare the effect of bending stress, as well as determining the relationship between the widths of the face and bending stress, and finding the values of stress through the equation of Louise and comparing them with the results of analysis of the ANSYS program.

KEYWORDS: Helical Gear Failure & Bending Stress

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Original Article

INTRODUCTION

Gears are necessary economically, as they enter into many industries such as cars, ships, equipment, aircraft, cranes, and others. Sometimes requirements transmission of power or torque from source to application by belt or robe, chain, but space is large. When required transmission velocity and high accuracy from driver to driven and distance are very small, for this reason, the use of gears, and others are required. The belts are flexible elements and are used when the distance between the axes is large and the chains have elasticity, but are preferred for medium distances. While the gears are used for very close distances, this type of transport is called positive movement because it does not contain sliding. Figure (1) shows two helical gears that are mated. Commonly used is helical gear when the application is quiet without noise [1]. Teeth of gears always subjected to many stresses, and this study focused upon bending strength of tooth gear. Therefore, it is necessary to use smooth driven and high-efficiency in gears [2].

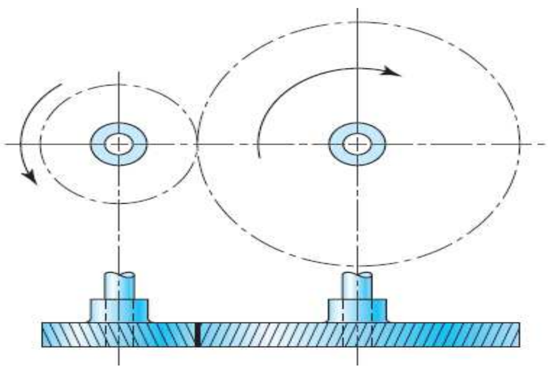

Figure 1

PROBLEM IDENTIFICATION

Many studies are focused on the failure of gears teeth by using theoretical analysis and others, investigated to compartment the outcome between numerical and theoretical calculations. This study investigated the effect of face width of the tooth gear on the strength bending. The effect of bending stress upon the root of gear tooth may be the reason for occurrence of failure. To prevent failure, it is to predict the value of the bending stress distribution along the gear tooth. The 3D modelling of helical gear is done by using Solid Works 2017 (*toolbox library at ANSI Metric*) and saved as IGS format file. Numerical analysis has been done by used ANSYS software v.16.1 (FEA). The comparison of results is done between theoretical (*modified Lewis equation*) and numerical (ANSYS).

LITERATURE REVIEW

The previous studies are examined and presented below.

- Focused on the bending stress at the different number of teeth for five models at a constant of the load and gets differences about (2.35% - 5.49%).
- Studied the bending stress and contact stress based upon acts of face width of the gear tooth and helix angle, and showed the importance of geometry parametric as it is expectant in the design.
- Compared results of bending and contact stresses and obtained difference about (6%) in bending and (3%) in Hertzian (contact) stress.
- Investigated from affect range of face width upon bending strength by AGMA and ANSYS, and used five values of face tooth, face width and helix angle that are important parameters of geometry to determine the stresses through gear design.
- Investigated bending stress and compared ANSYS with AGMA and obtained little difference in percentage (4.3%).
- Interested in bending and contact stresses and compartments, obtained the results that have a little variation between FEA and AGMA calculations. Percentage error is very little about 1.21 % in bending strength and 0.613 % in contact stress [6].

$$T = \frac{P*60}{2\pi N} = 185.68 \text{ N-m}$$

$$\text{Module} = D/T$$

D_g = 138 mm D_P =74.81 mm

$$v = \frac{\pi DN}{60} = 7.05 \text{ m/s}$$

$$W_t = \frac{T*2}{D} = 5305.164 \text{ N}$$

$$W = \frac{W_t}{cos(\emptyset_n)cos(\alpha)} = 6008 \text{ Mpa}$$

Circular pitch

$$p_c = \frac{\pi D}{T} = 18.8 \text{ mm}$$

$$\sigma = \frac{K_v * W_t}{F * m * Y}$$

b=25 σ= 388.6 MPa

b=30 σ= 323.8 MPa

b=35 σ=277.610 MPa

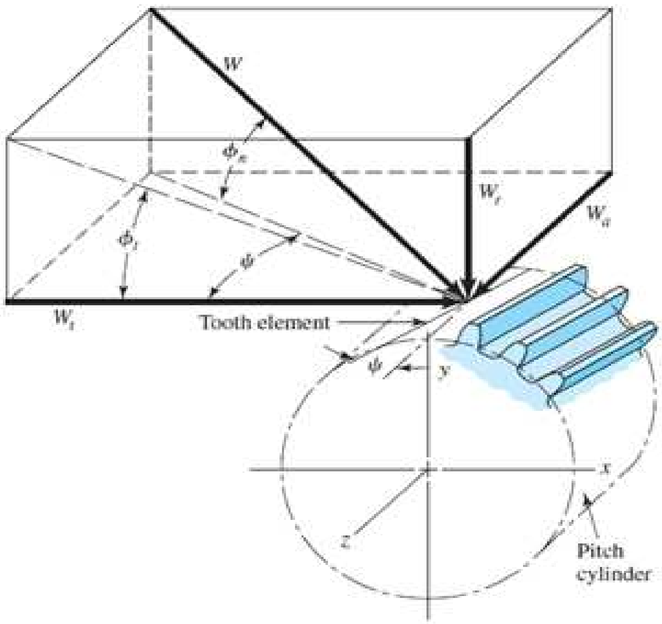

Figure 2

Table 1: Design of Helical Gear

No	Parameter	Symbol	Value
1	Pressure angle	ϕ	20^o
2	Helix angle	α	20^o
3	Module	m	2 mm
4	Thickness of tooth	t	(25,30,35)
5	Number of teeth pinion	T_p	30
6	Teeth of gear	T_g	60
7	power	P	35 KW
8	speed	N	1800rpm

SOLID MODELLING AND ANALYSIS

A geometrical model of helical gear is done with Solid Works as shown in Figure (3) and Figure (4) and we have generated mesh on the helical gear as shown Figure 5, and Analysis is done with ANSYS Work bench 16.1. The models after import, the model of helical gear is as shown in Figure 6.

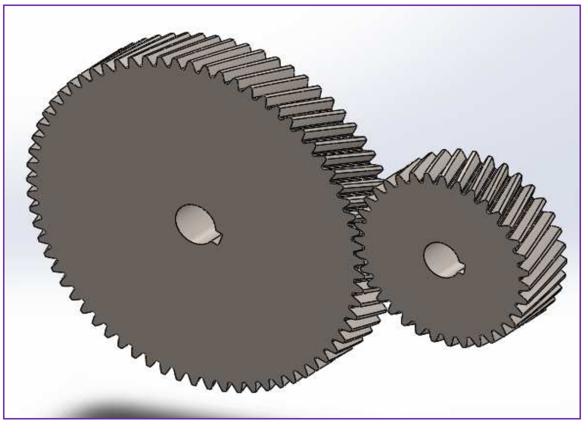

Figure 3

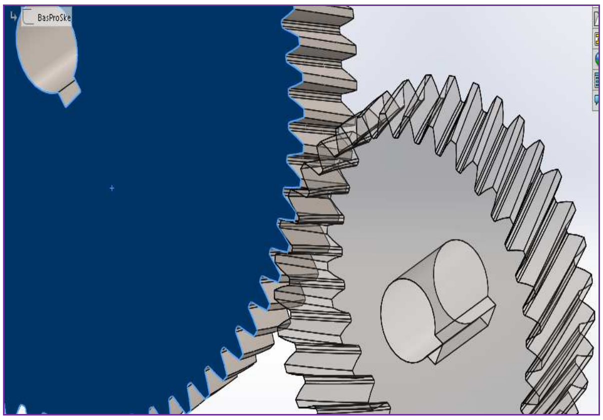

Figure 4

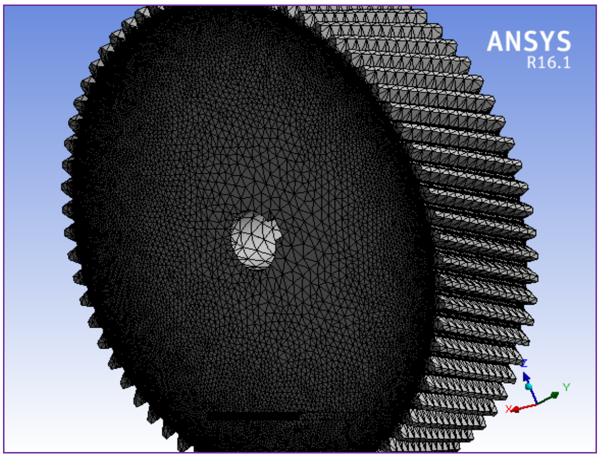

Figure 5

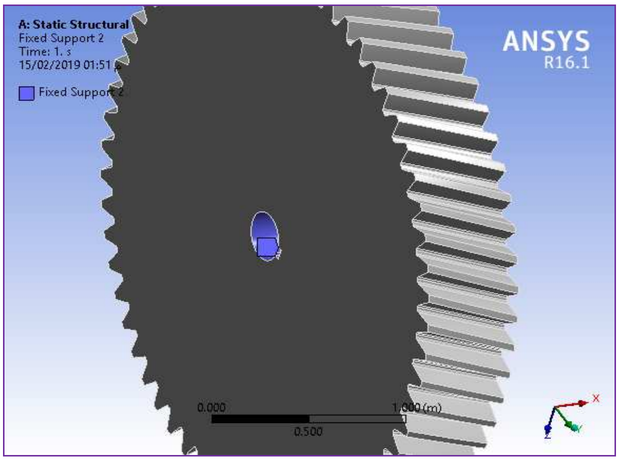

Figure 6

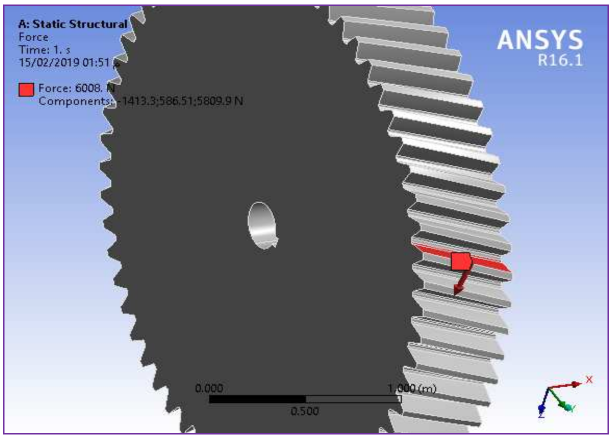

Figure 7

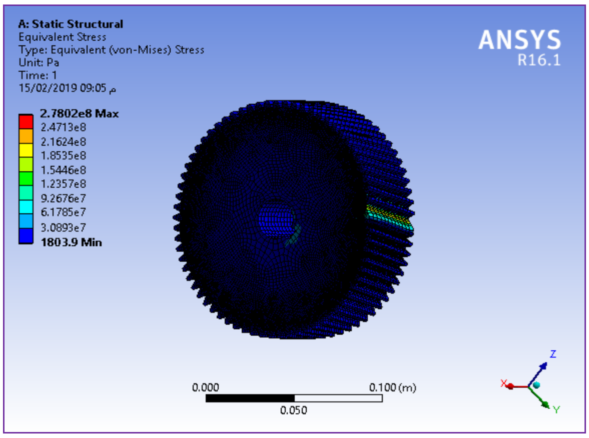

Figure 8: b=35

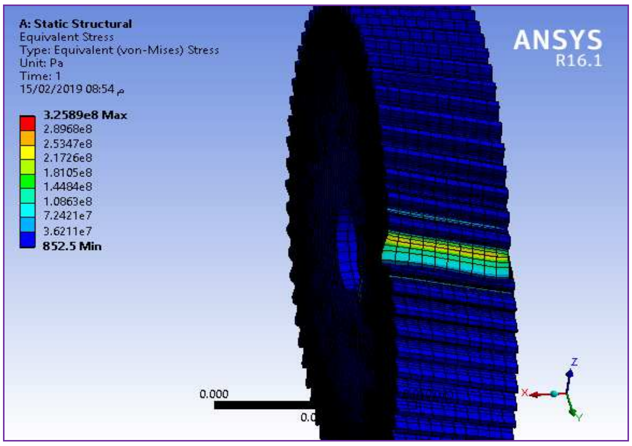

Figure 9: b=30

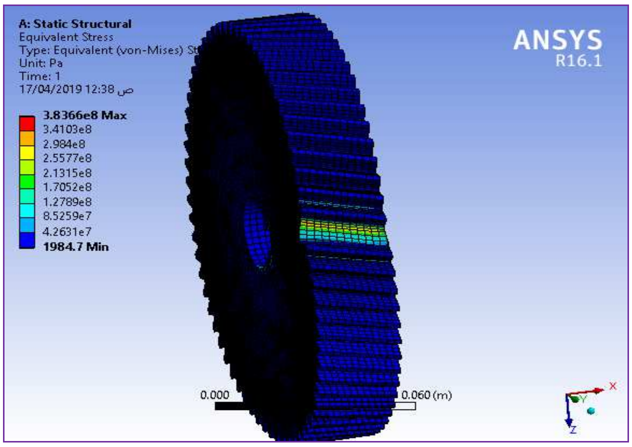

Figure 10: b=25

RESULTS

Bending strength of tooth of helical gear was analyzed by using ANSYS software 16.1. The table (2) shows compartments of results.

Table 2: Results

SI. No	Face Width (mm)	Bending Stress(Mpa) from Lewis Eq	Bending Stress(Mpa) from ANSYS	% Change
1	25	388.6	383	-1.4 %
2	30	323.8	325.8	0.6 %
3	35	277.610	278.02	0.1 %

CONCLUSIONS

The results of maximum bending stress decreases with the increase of face width of the gear, through comparing the numerical solution (FEA) with the theoretical calculation (by Lewis equation). A maximum bending stress of -1.4 % is observed at a face width of 25 mm. and minimum bending stress of 0.1 % is observed at a face width of 35 mm.

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